THE BULLETIN
OF THE
AMERICAN CERAMIC SOCIETY

A MONTHLY PUBLICATION DEVOTED
TO THE PROMOTION OF CERAMIC
EDUCATION AND TECHNOLOGY

OCTOBER • 1933

VOLUME 12 NUMBER 10

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THE BULLETIN

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Publication Office: 20th & Northampton Sts., Easton, Pa.
Editorial and Advertising Offices: 2525 N. High St., Columbus, Ohio.
Executive Office: 2525 N. High St., Columbus, Ohio.
Committee on Publications: L. NAVIAS, *Chairman;* L. J. TROSTEL, M. F. BEECHER, R. M. KING, ROSS C. PURDY
Entered as second-class matter at the post office at Easton, Pa., under the Act of March 3, 1879
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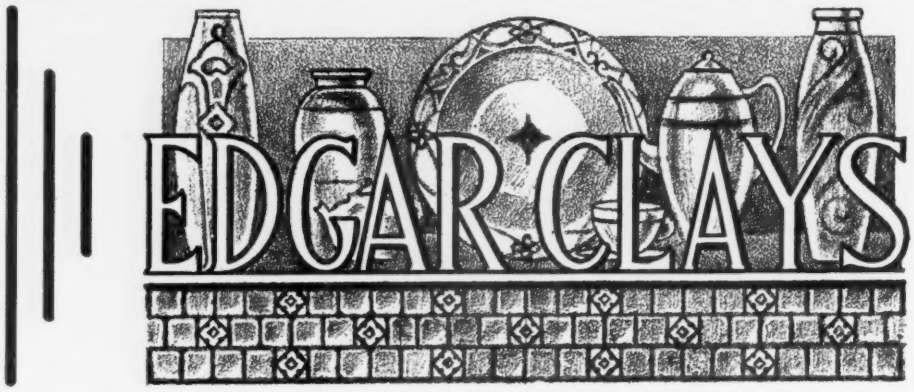

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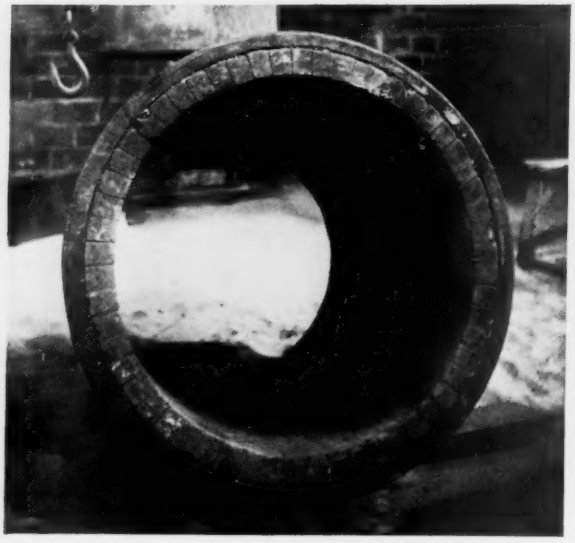

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THE BULLETIN

A Monthly Publication Devoted to Proceedings
of the Society, Discussions of Plant Problems, Discussions
of Technical, Scientific, and Art Questions, and
Promotion of Coöperative Research

Vol. 12 October, 1933 No. 10

EDITORIALS

THE CONTRIBUTION OF ENGINEERING TO PROGRESS—A REVIEW AND EVALUATION*

By Edward J. Mehren†

I. Introduction

America this week is witness to a situation which many may consider paradoxic and which is at least dramatic.

On Chicago's lake front lies a great World's Fair—from beginning to end a glorification of the scientist and the engineer, an exposition of the physical achievement of the machine age.

To it this week have come America's engineers. But while they look and appraise, while they acclaim and are acclaimed, the world declares that the machine age they have created has failed and is responsible for our present economic and social debacle. "You have contributed to man's leisure, comfort, and convenience," add the challengers, "but the results have been mental flabbiness and weakened morality. There has been no true progress." Such are the charges thrown at the work of the engineer in the very week that he gathers here at the great Fair.

This, then, the drama that America witnesses: it sees him face to face with his handiwork; it asks what answer he will make, for if his work has failed, so has he.

Here then the challenge must be met; never was the time more opportune.

Has engineering contributed to progress?

Has there *truly* been a century of progress?

II. Depression Gives Point to Inquiry

But there is another reason for facing the charge. Even were our social and economic systems intact and orderly, the meeting of these societies at such an exposition would demand a discussion of this kind. The machine age has been consistently under challenge for a score of years and more particularly since the close of the World War. Its effect and impact need inquiry, for engineering is now the basis of our economic system, it determines our social order, it goes down into the life of every individual and affects him for weal or for woe.

The present depression, therefore, does not dictate the topic. It *does* make it more pointed and more pertinent.

III. The Vicissitudes of Progress

When we speak of progress we mean movement or development in a desirable direction. I conceive that humanity is traveling a long road whose desirable direction and goal are the happiness of all mankind, accompanied, first, by a wide diffusion of this world's goods; second, by the highest order of intellectual development of which individual men are severally capable, and third, by high moral attainment, which may be expressed as that "peace with God and peace with ourselves that surpasseth all understanding." This is the goal, this the ideal.

Let us note that the goal of humanity at large can not be defined solely in terms of happiness. Happiness is contentment with one's condition. The anchorite on the desert, with no family to care for, with few wants, sunk in contemplation and service of his Maker, was happy. So are the tribes of the South Seas. But neither condition can be the ideal for the race as a whole. The one is an unsocial life; the other, untouched by intellectual fire. Therefore, while some may stop by the wayside and be content with their lot, the race must go on to a higher common destiny,

* Address before the Joint Dinner of The National Engineering Societies during Engineers' Week at A Century of Progress Exposition, Chicago, June 28, 1933.

† President, Portland Cement Association.

and that destiny includes not only happiness but social development and spiritual achievement.

But the long road that mankind is traveling is cut by ravines and chasms, some shallow, some deep and precipitous. The ravines and chasms are greed, exploitation, oppression, war, hunger and famine, insanitary surroundings, disease, ignorance, vice—and all those other hindrances which interfere with man's progress. At the beginning of recorded history, humanity toiled down into each of the chasms, forded the streams, and toiled up the opposing banks. Progress was slow.

In time, advancement of the arts, better social organization, education, and religion built bridges across the streams, at first only high enough to clear the flood. Further advances raised the bridges to higher levels, made them safer against floods, and reduced both the descent and the upward climb. Could the job ever be completed, we would build a bridge over every chasm from bank top to bank top. The chasms in effect would disappear and humanity would go forward joyously on a high road—a true *high* way—to its destiny.

In the past there have been floods in the chasms, and the bridges, often high ones, have been swept away. War, pestilence, the incursions of barbarians, a recrudescence of ignorance, the twilight of religion, the re-triumph of greed—have thundered down the canyons and all but wiped out the achievements of the past. Painfully, humanity has had to start all over in building, in raising its bridges, in its conquest of the chasms.

Using the simile of the road, our questions can be paraphrased in this way:

"Has engineering helped to build bridges over the chasms, has it raised them to higher levels, has it made them more secure, has it brought nearer that high road without dips on which humanity can go forward joyously to happiness, to more uniform enjoyment of this world's goods, to high intellectual and moral attainment?"

IV. Engineering in Itself

I take it that it is entirely unnecessary to speak of engineering achievements in themselves. The whole world concedes that in every branch of engineering our machines, mechanisms, processes, and structures outstrip those of any previous day.

We are interested, however, not primarily in machines but in their effects.

V. Contribution to Social Progress

Our first inquiry properly relates to the influence of engineering on social progress; that is, on the distribution of wealth, on its effect on men—its effect on them externally and in their relations to others.

We are here not in the realm of conjecture but of fact. We find that in the Western world today, more than ever in man's history, the masses of men are better fed, better clothed, better housed; health is better, life has been prolonged, infant mortality reduced; elementary education well-nigh universal; secondary and advanced education available to all who would have it; liberty greater; opportunity for individual advancement unhampered; justice more equitably distributed. In fine, there is a higher standard of living, and a very high order of social advancement.

The question of wealth deserves special consideration. Wealth today is not only greater in the aggregate, but more widely diffused. The distribution is not entirely equitable, but it is not so disproportionate as those imagine who think only of private property and forget the immense treasury of community wealth. The first is the possession of the individual; the second, the possession of all, for their comfort, convenience, and use. In community wealth never were people richer—in the number and quality of streets and roads, in the purity and amplitude of water supply, in the sanitation and lighting of cities, in fire and police protection, in courts of justice, in medical, educational, and recreational facilities.

How can we account for this increase in the standard of living, this extraordinary social progress, this wide diffusion of wealth?

The explanation lies in a profound but very simple fact, as fundamental and as elemental in the economic order as the commandment, "Thou shalt not steal," is in the moral. If we are to appreciate the significance of the engineer and the engineering age, if we are to comprehend the world through which we have been passing, if we are to penetrate the present economic convulsion and understand the economics of what is ahead, we must understand this primal fact and let it sink into our consciousness. That fact is this: *that through the engineer's development of power we produce wealth more rapidly today than at any previous period in man's history.*

It is this increase in the rate of wealth production that has given us the facilities, conveniences, comforts, and advantages of which I have spoken. To this do we owe our great private and community wealth, our high standard of living, our high level of social advancement.

We must conclude, therefore, that engineering, by increasing the production of wealth, has made an extraordinary contribution to man's social progress, it has builded high the bridges over the chasms that hindered his social advancement.

Thus do we answer the first part of our inquiry.

VI. Intellectual Development

We come now to the second part. Has engineering contributed to intellectual and moral development, has it bridged at higher levels the chasms that have held back his spiritual progress?

Here our critics will rage. The age is decadent, they tell us; we are flabby intellectually, we have backslid morally. We have much information, they say, but little wisdom; alert perceptions, but little culture; athletic bodies, but no rigidity of moral character.

Are we able to answer the indictment?

There may not be a single luminary today of the brilliance of Shakespeare or Dante or Aristotle, but our age *is* one of striking intellectual vigor and activity. We must not make the mistake of coloring the entire Elizabethan age with the stature of Shakespeare, nor think that the whole Greek world was up to Aristotle's level.

If our galaxy has not a dominant luminary, it nevertheless has many great suns. In every line of human thought, the output of our researchers is prodigious. If an age is to be judged by the sum total of its contribution to human knowledge, then ours must be given high rank.

Each age too, has its own *Zeitgeist*, the spirit of the age. Ours is science, pure and applied. In those fields we are making an intellectual contribution of stupendous proportions. In astronomy, physics, chemistry, biology, medicine, and engineering we stride with seven-league boots.

We claim, too, as an intellectual accomplishment the spread of education, common, secondary, and higher, to the masses of men in the Western world. To reclaim people from ignorance, to open to them the storehouses of knowledge and of wisdom, to make possible, yes easy, for any one who wishes to secure it the very highest education, is indeed an accomplishment of which the machine age may justly be proud. That the education of the will has not gone along as lustily as the education of the intellect is a charge we will have to admit, but it does not completely negative the intellectual achievement.

Yes, my friends, even in the intellectual sphere, the resources of wealth furnished the Western world by engineering have enabled mankind to raise higher the bridges that span the chasms of ignorance and prejudice and bring nearer the day of the great high road for attaining humanity's goal.

VII. Moral Condition

But what of our moral life? Who shall judge it? Not I. There is no more difficult task for the historian than to determine the moral tone of an age—to strike the average from king to peasant, from president to humble citizen. In this respect no age can be sure of its appraisal of itself. The human soul—the millions of human souls of the Western world—can not be weighed or calipered.

Certainly we are not morally what we would like to be or ought to be. That can be said of our intellectual stature as well.

But if our age has not risen to the intellectual and moral standard that we would wish, if we have not raised to top height the bridges over the chasms that handicap our intellectual and moral lives, the fault is not that of the engineer, but of the very teachers, religious leaders, economists, and statesmen who are today his critics. We find here another fundamental and elemental principle that should be stressed as strongly as the rapidity of wealth production. It is this: that the engineer has created an environment far more favorable to widespread intellectual and moral growth than the world hitherto has ever known.

Let that, in turn, be *our* challenge.

Our work has been well done. We have removed the burden of toil from the backs of men; we have made them masters of power rather than power machines; we have discounted their sinews and exalted their minds; in freeing them from drudgery, we have given opportunity for the use of their intellects—that part of their natures made in the image and likeness of God; we have placed education at their disposal; we have assisted in freeing them from disease and prolong-

ing their lives; we have shortened the hours of labor; we have given them leisure in which to invite their souls and grow morally and intellectually.

Here is an environment for spiritual growth such as the world hitherto has never known. Possibly humanity moves too slowly to make full use of this environment at once, but blame not the engineer for the failure.

VIII. Failures of Our Critics

It is because the economist, financier, the statesman, the teacher, the religious leader have not been able to keep pace with the engineer that untold difficulties arise. The more rapid creation of wealth has changed the whole base of Western civilization. It is the misunderstanding of this factor and the failure to recognize its profound and all-pervasive influence on finance, business, the distribution of wealth, national and international politics, and on human thought and outlook that have thrown the Western world into its present crisis and baffled its statesmen.

A few homely examples will illustrate the point, without going into the intricacies of finance or international politics.

Machine-power agriculture on the one hand and industrial development on the other have removed millions from their attachment to the soil, concentrated them in the cities and deprived them of their security. As Dr. Steinmetz put it, they have been exposed to the three great fears—fear of unemployment, fear of illness, fear of an unprovided-for old age. And while this has been brought about by the progress of power, the statesman, the financier, the economist have not kept pace and found ways to banish these fears and, by using the new wealth, to restore the security that men enjoyed when attached to the land.

Second, there has been tardy recognition that too large a proportion of the wealth created by the machine has been reinvested in more machines and too little diverted to consumable goods and community services. It is one of the keen lessons of this depression that an age that creates wealth as fast as this one does will have much of that wealth confiscated during depressions if too large a proportion goes back into the extension of production facilities. Here again, finance and political economy lag behind the work of the engineer.

A final illustration: Highway transport—the combination of the hard road and the automobile—has made township government and small counties obsolete—survivals of the horse-and-buggy days. Township governments should be abolished, counties consolidated. The automobile makes it logical, but the politician insists that the anachronism continue.

IX. Not Entirely to Blame

But if these other groups have not been able to keep pace with the engineer, we should not be too critical. We have behind us 60 centuries of recorded history, in only two of which has modern engineering been a factor. In fact, Watt was a man of only yesterday. We can almost touch his times. He died in 1819, and the grandparents of many of us might well have known him.

The machine age, then, has been operative for less than three per cent of recorded history. It is still a new instrument in the life of the race. We have not learned its mastery. We have not made it fully servant of the whole of mankind.

In the early days of steam engineering there were heaven-crying cruelties in its application. Strong hands seized the new wealth-creating mechanism and turned it to their own selfish ends. Engineering at that time, instead of bridging chasms, was used by greed to dig them deeper.

Later, as its benefits became more widely diffused, we used its gifts too lavishly. Our whole age, every one of us, is of the new rich in a large sense; and we used the new wealth—as the new rich always do—extravagantly, lavishly, even boisterously. We have not had the strength to resist the complexity and material temptations of the new wealth and patiently, calmly, taking advantage of the superior environment, let it work out in us a holy enlargement of intellect and soul.

But be assured that we are mastering, we will master the new instrument. Much of what has been going on in Washington in the last three months is an effort in this direction. The phrase "the forgotten man" is not a mere political catchword but the expression of a fundamental social philosophy.

Our contention, then, is that we engineers have not only builded higher bridges across the chasms, but have furnished the materials for still higher bridges if the statesmen, economists, teachers can learn to use them.

We believe that there has been a century of progress.

X. Conclusion

Solemnly we look back on the arduous work of the race, struggling through 60 centuries or more in its effort to raise a high road over which to travel to its destiny—widespread happiness, with reasonable physical comfort, a high intellectual level, and a high moral order. In the nearly two centuries of steam power, engineering's record is not clean. In its early days, seized by greed, it tore down bridges instead of raising them. Latterly though, it has been made more and more the servant of the race, it has raised high the bridges over the chasms that impeded social progress; it has helped bridge the chasms of ignorance and moral turpitude by creating an environment far more favorable to intellectual and moral development than in the past.

It is in the faith that he was making a contribution to the race that the engineer has worked in the past 100 years, faith that he was bridging the chasms on the highway of mankind. In that faith will we and our successors carry forward in the century ahead so that when *its* history is written, it may more truly be set down as a century of progress.

In that faith will we work, not primarily that man may have greater comfort and more leisure, but that these may contribute to a more vigorous intellectual and a higher moral life.

"Not in bread alone doth man live but in every word that proceedeth from the mouth of God."

IS CERAMICS PHYSICS OR CHEMISTRY?

For these forty years, since Prof. Edward Orton, Jr., started a ceramic department at Ohio State University, ceramics to most people has been considered applied chemistry or the chemistry of silicate minerals plus the engineering of ceramic ware production.

So much emphasis has been placed on the idea of the chemistry of ceramic ware compounding that perhaps not enough thought has been given to the possible value of a more extended training in mathematics and physics.

The October issue of the *Journal of the American Ceramic Society* was devoted exclusively to a review of equilibrium studies in silicate mixtures. Almost all of those studies were made by scientists whose major training has been in mathematics and physics.

Those men in the ceramic industry who are most fundamental in their ceramic researches are, for the most part, men who have majored in mathematics and physics rather than in chemistry or those to whom mathematics and physics are attractive and usable. Those men who have earned the degree of Doctor of Science majoring in physics seem to have greater facilities for developing fundamental concepts into practical results, due, perhaps, to having acquired a more analytical thought habit and procedure.

A chairman of a collegiate department of physical chemistry, in a club room conversation, stated that those in his classes who took the course known as Engineering Physics led in ability to comprehend and to use physical chemistry. A professor, who for over thirty years has taught quantitative chemistry, frankly added that no more than a general course in chemistry, such as is given to freshmen in college, is needed to make one proficient in working out physical-chemical problems.

Thermochemical mineralogy possibly is a misnomer; more accurately it is thermophysical mineralogy, since equilibrium reactions are physical orientations of molecules, solid solutions, and crystal alterations. Geophysical reactions in nature are the same as those in the so-called thermochemical mineralogy as well as in ceramic meltings and fusions.

It is true that chemistry is molecular physics. Valence is considered to be due to the physical peculiarity of the surface of molecules. Molecular structures are alterable and those who have an understanding of molecular physical systems have been able to produce new and very useful products in plastics, lubricating oils, rubber compounds, and several other organic products.

Chemical alterations and reactions do take place when ceramic mixtures are fired to partial or complete fusion, but are these the more essential or major reactions on which the properties of fired ware depend?

PAPERS AND DISCUSSIONS

TEST FOR CHEMICAL RESISTANCE OF GLASS CONTAINERS*

By F. C. Flint and A. K. Lyle

I. Introduction

The numerous uses of glass and the variety of glass compositions employed make it impractical to apply a single standard test in order to predict the chemical resistance of all shapes and compositions. The chemical durability of glass is not a simple case of solubility. It is far more complex in reaction than even the most general idea of solubility would imply. Even if it were the case and if solubility were the basic idea, all classes of glass could not be measured with one index. G. W. Morey[1] has described the process of corrosion of glass which involves miscibility of glass and water and later the complete decomposition of the glass. The term "solubility" has no meaning in this connection. The problem, however, first calls for separation of glasses according to their use and then according to their composition. It would then be possible to apply a test indicative of the chemical resistance for glasses of each class and composition.

Classification by use indicates flat and optical ware, tableware, chemical ware, and containers. Classification by glass composition would separate the extremely basic glasses or the enamels from the highly acidic glasses, and should include special glasses, borosilicates, and lead glasses.

Because of the number of variables, it does not seem possible to develop a universal test for glass in general. Most of the test methods apply to some definite glass composition with particular attention drawn to the use of the finished product.

II. History

A great deal of work has been done in England, Germany, and America on tests for the resistance of glassware to chemical attack. This work has also indicated by its very extent that a simple standard test can not be applied.

The first work of any magnitude and authority was done in Germany. The work by Mylius,[2] Foerster,[3] and Kohlrausch[4] was a generalized endeavor to find the best compositions of glass to be used for special purposes. Some generalizations were made as to the influence of various constituents in the glass on its resistance to attack. This research presents in a qualitative manner the relation of glass composition to its chemical resistance and the relative activity of various chemicals as attacking media.

The war brought forth in England and America more studies on chemical glassware. Some work was privately conducted and tests were developed. Most of these tests as described deal primarily with analytical reagents and their influence on glass. The new production of optical instruments during the war also called for an interest in optical glass and its resistance to weather attack. Some specialized tests were developed which showed the condition of the surface after accelerated conditions of attack had been produced. Very few of these tests were quantitative and, even when quantitative, were often not of general application.

W. E. S. Turner[5] and his co-workers did a great deal of work on this subject, checking over methods and developing modifications which were satisfactory for some purposes. They made extensive studies on the influence of the glass composition which were helpful in the manufacture of resistance glass. Turner has adequately summarized the various types of test used which include low-temperature and high-temperature tests with water and other chemicals. Generalizing then, it is obvious that tests on glass have to contend with a material which, though uniform in general physical properties and appearance, may have an extreme variation in chemical composition and resultant chemical resistance. Glass is of such wide applicability that its uses may determine whether or not the type of tests to be given offer significant

*Presented at the Annual Meeting, American Ceramic Society, Pittsburgh, Pa., February, 1933 (Glass Division).

[1] "The Corrosion of Glass Surfaces," *Ind. Eng. Chem.*, **17** [4], 389 (1925).

[2] "Testing the Surface of Glass by Color Reaction," *Z. Instrumentenk.*, **9**, 50 (1889).

[3] "Chemical Behavior of Glass, etc.," *Ber. deut. chem. Ges.*, **25**, 2494 (1892).

[4] "Solubility of Some Glasses in Cold Water," *Ann. Phys. Chem.*, **44**, 577 (1891).

[5] J. D. Cauwood, S. English, and W. E. S. Turner, "The Attack of Chemical Reagents on Glass Surfaces," *Jour. Soc. Glass Tech.*, **1**, 153 (1917).

results. What is important in one field may be of negligible importance in another.

III. Classification of Glass Based on Shape and Use

Glass may be classified for the purpose of chemical resistance tests based on shape and use as flat, optical, tableware, chemical ware, ampoules, and containers.

Flat glass is subject to water attack of "fading." The same holds true of optical glass. The chemical durability of tableware has seldom been considered until recently. Chemical ware has been developed for thermal resistance as well as chemical attack and in the solution of this problem glass has been produced sufficiently resistant for most problems of chemical attack.

In like manner, until recently, no particular attention has been given to the chemical resistance of glass containers. As the variety of products packaged in glass has increased, many problems of chemical resistance have been presented. This change is particularly noted in connection with pharmaceuticals that are now sold in unit containers instead of being dispensed by a druggist as needed.

Some attempt has been made to apply standard tests. Ampoules, which are required to withstand sterilization and to be stable toward a variety of solutions, are graded by special methods. The British Society of Glass Technology has developed a standard test, and other standard methods are presented in the United States Formulary and the German Pharmacopoeia.

It is evident from present knowledge that the test must be designed to fit the case. It must have a close relation to the actual use of the glass and be an index of its future service. Optical glass may be tested in various atmospheres to give an accelerated weathering test. A similar test can be applied to window glass. For studies of glass composition, powder methods which eliminate in a large part surface and annealing effects may be used.

In any test the variables should be known and controlled. Only glasses of similar composition may be accurately compared. All ordinary glass containers are of sand-soda-lime composition. The use of relatively small amounts of alumina or boron does not affect this classification. It should be possible therefore to apply some standard test to containers.

NOTE: In testing containers it should be definitely understood that special glasses, such as are used for ampoules, heat-resistant glasses, and lead glasses, are not involved. Containers as generally understood are of common soda-lime composition and are used under ordinary conditions of storage.

The test in some measure should approach the actual use. This condition can be met by using the container itself with the test applied to its inside surface. It is important to mention that the inside surface of a blown container is uniform and that it is not subject to variation from mold defects or rough handling.

Problems are also presented in another phase, not physical or chemical. The bottles are made by a manufacturer who knows glass but knows relatively little about the product which is put into the container. The glass is used by a man who knows his product but has relatively little knowledge about glass. It is unreasonable to expect every user of glass to become expert in the manipulation of the glass he buys. It is also unreasonable to expect a glass manufacturer to be expert with food products, pharmaceuticals, and chemicals that may go into glass containers.

The requirements then in developing a test should be not only to devise a test by which the glass can be evaluated but to make one which can become the common meeting ground between the glass manufacturer and the user of his product.

IV. Test Conditions

The difficulty in choosing a test which may be definitely and easily understood in two wide branches of endeavor is not always recognized. A laboratory equipped for one type of operation sometimes looks askance on what, in another field, would be a simple manipulation. For this reason distilled water was chosen as the attacking medium, as it is a chemical easily obtained, uniformly well known, and of sufficient activity to give a measurable attack under proper conditions. A test in which distilled water is held inside of a container for six hours at 138°C in an autoclave and followed by titration of the alkali extracted with standard acid can be applied under a wide variety of circumstances and with a confident feeling that reliable results can be obtained. The aim is to give a measure of the relative reliability of glasses of similar general composition and comparable physical history rather than an absolute index in centigrade-gram-second unit. The fact

is strongly emphasized that in any chemical-resistance test only the rate of reaction under some particular condition is measured. The reaction does not go to completion unless the whole of the article is destroyed.

The reaction has been only slightly accelerated, since complete breakdown is not desirable. The reaction at 138° and 35 pounds pressure is not to be compared with the higher temperatures used in many autoclave and bomb tests. At this relatively low pressure, the attack can be compared directly with the attack found at ordinary temperatures and pressures. An accelerated test has the advantage of completion in one day. The one-day limit and the use of water necessitate the use of an elevated temperature to produce sufficient attack to make the corrosion measurable in all cases. It is conceded that the reaction at higher temperature may be somewhat different from that at normal temperature but, in general, it is in the same direction.

The particular advantage lies with the user since he can be supplied with glass to pass a definite specification. The specifications can be written for the particular bottle in question. It takes very little experience in testing various sizes and shapes to be able to predict quite closely an expected result on a given style of container. This is often quite difficult to give because of the irregular shape of the inside of many bottles. If the area were used, calculation or estimate would be needed in figuring the expected attack on various sizes of containers.

Most containers have a more or less definitely understood rated capacity, and specifications named for a given size are easy to interpret by a person who does not have technical knowledge. For instance, the specification may call for a definite chemical durability expressed in grams of an alkali as sodium hydroxide extracted from a given sized bottle under the conditions of the test. The user of the glass will be assured of a continuous supply of containers of uniform chemical resistance and in addition he will be able to check the results for his own satisfaction. This makes the test a common ground of understanding. It does not mention the particular chemical the purchaser is going to put into the glass, but the purchaser can set up a comparison between his own product and the glass standard which is named. If the average glass container of 6-ounce capacity will test 0.14 gram of sodium hydroxide per liter and a greater chemical resistance is desired, a value of 0.12 or 0.09 may be specified by the purchaser.

This eliminates the necessity for the glass manufacturer to become familiar with a variety of special products and it also eliminates costly knowledge of glass gained by slow experience by the user of the glass.

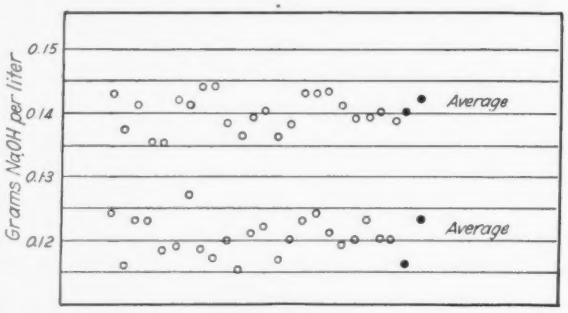


FIG. 1.

Figure 1 shows results from a thorough test of the consistency of the figures obtained by the autoclave method as described. The variation amounts to approximately 0.01 gram NaOH per liter. The two types of glass are clearly separated by the results. These checks are readily obtained when all the details of the method are followed. The importance of exactly following the time-temperature schedules must be emphasized to any one who does not readily recognize the influence of those factors in an accelerated test.

The range that can be expected in a wide variety of normal bottle compositions is from 0.08 to 0.18 gram NaOH per liter. In a 6-ounce container this permits the use of sufficient $N/10$ HCl to insure accuracy under ordinary laboratory procedure.

V. Autoclave Test

The autoclave test has been in active use substantially as given for a period of four years. It has always indicated the relative value of changes in composition and always has given a figure which would readily check tests by the user of a particular pharmaceutical or food product.

(1) Outline of Method Bottles filled with distilled water are placed in an autoclave and held at 138°C (35 pounds steam pressure) for 6 hours. The entire contents of the bottle are titrated with standard acid using methyl red as the indicator. This titration is calculated to grams of NaOH and finally to grams of NaOH per liter.

This method is designed to give a rapid test for the chemical durability of the glass or of the bottle

itself. The calculations are based on the capacity of the bottle and not on the area of the inside surface. This method penalizes bottles of small capacity since the exposed surface is larger in proportion to the amount of liquid contained. In other words it gives a figure representing the efficiency of any bottle as a container. The method also takes account of odd shapes which may not be as efficient as cylindrical bottles and are more subject to attack.

(2) Method in Detail (*a*) Apparatus: An autoclave to stand 50 pounds' pressure equipped with a thermometer and a gage accurate to 1 or 2 pounds; (*b*) standard acid $N/10$ HCl; (*c*) indicator methyl red (0.02 gram of the free acid dissolved in 100 milliliters of hot water, cooled, and filtered).

The distilled water is put into the autoclave to the fill line which is usually indicated and the water is brought to the boiling point while the autoclave is still open.

The bottles for test are rinsed with distilled water and filled with a definite number of milliliters which should approximate the rated capacity of the bottle, *i.e.*, a 4-ounce bottle would require 118 milliliters of distilled water. The bottles are then capped using caps with the liners removed so that there will be some leakage, or they may be corked loosely. The standard method of capping the bottles consists in removing the liners and screwing the cap down using the thumb and two fingers so that a tight seal will not be made. This capping is necessary in order to prevent mechanical loss of the liquid from the bottles during cooling and still allow the pressure to be the same inside the bottle as on the outside.

While the water is boiling the bottles contained in a rack are placed in the autoclave. The water should not reach the bottles. The cover is fastened down tightly, but the exhaust valve on the top of the autoclave is left open. Steam should be allowed to escape from this valve for a short time in order to rid the apparatus of air and dissolved gases. With no pressure at the gage the temperature should be 100°C. The valve should be closed and the time recorded as time when starting. As soon as the pressure in the autoclave reaches 35 pounds the time is again recorded as time when pressure is reached. The elapsed time may be 20 to 40 minutes. A pressure of 35 pounds and a temperature of 138°C are maintained for 6 hours. The flame is then removed from the bottom of the autoclave and the time is again recorded as time when finished. This elapsed time should be exactly 6 hours. The autoclave is allowed to cool until the pressure diminishes to about 5 pounds. If desired, the cooling may be accelerated by the use of a fan. The exhaust valve on the top of the autoclave can then be opened carefully so as to reduce the pressure slowly. As soon as the pressure is entirely released the time is again recorded as time when cooled. This elapsed cooling time should not be more than 30 minutes. The autoclave is then opened and the bottles, which are still quite hot, are removed immediately. As soon as the bottles are cool enough to handle, the contents of the bottles are measured and the volumes recorded as milliliters at finish. The normal difference between the volume of liquid at the start and that at the finish of the test is 10 to 25 milliliters. A greater difference indicates mechanical loss. The bottles are then rinsed and the original liquid plus the rinse water is titrated with the standard acid ($N/10$ HCl) to the first faint color change of methyl red. The titration is recorded and calculated as grams of NaOH. This result is finally calculated to grams of NaOH per liter based on the number of milliliters originally put into the bottles.

A standard bottle is carried through this same run and the results are recorded. This gives a check on the operation. The proper result for the standard bottle is determined by making several runs. The variation from the average among these various runs should be less than ± 0.005 gram NaOH per liter.

HAZEL-ATLAS GLASS COMPANY
WASHINGTON, PENNSYLVANIA

TIME STUDY AS A BASIS FOR CONTROL OF DIRECT AND INDIRECT MANUFACTURING COSTS ON PORCELAIN PRODUCTS*

By A. W. Hough

The porcelain plant of the Pittsfield Works of the General Electric Company normally numbers one hundred and sixty persons. The kiln equipment numbers ten $16^1/_2$-foot periodic kilns of the Solon type. The products manufactured are chiefly cutout boxes, terminal boards, and other insulators for electrical apparatus. Parts are molded by both wet and dry process.

While many of the labor operations in this department were paid on a piece-work basis previous to 1925, the management felt that appreciable benefit would be derived, both in reduced and more consistent labor costs, if a thorough time study were made on all of the operations performed. The general problem, however, was approached with considerable concern due to the peculiar nature of the product.

Porcelain is, of course, an extremely fragile material up to the point of firing in the kiln. Even then, careless firing or mishandling of pieces during the loading and unloading of the kilns will cancel all of the painstaking efforts of those handling the pieces during the preceding operations.

In the manufacture of this ware there seemed to be a general share of losses from various sources and certainly no increase in this item could be tolerated. In fact, pressure was constantly being exerted to reduce the losses which were then prevailing. The opinion was offered that if the employees were speeded up in their respective operations the results could be measured immediately in the increase in the scrap pile.

All of the problems that were likely to be encountered were given careful consideration and it became obvious that quality control should become a part of the wage-payment plan with all of the "key men" in the department sharing in the benefits of the reduced overall costs. All controllable items of expense, scrap losses included, would be factored in determining the bonus for these key men. The so-called Bedaux or point system incorporated a comprehensive supervisory bonus plan as part of the system, and this plan was selected for installation.

It is well to emphasize the fact that with the introduction of time-study and incentive plans in any department, the most critical period occurs during the preparatory stage. A definite plan should be worked up, making sufficient time studies to give the management a sound estimate as to what savings can be accomplished by careful job analysis. This is especially true of the day work shop, but it also applies to the piece work shop where piece prices are not set up on a time-study basis. In the present case, a proposition was worked up showing the estimated savings possible from the installation. A report was also made on the time required to take the time studies, to make the application of the time standards, and to set up the standard allowances for the supervisory or key men bonus.

With these definite facts, the plan was approved by the superintendent of the porcelain department, after which the full coöperation of the key men such as floor foremen and gang leaders was enlisted. The general objects of the program were discussed and the desirability of time study from their viewpoint was given, such as more consistent time allowances and a better planning of work and deliveries. The time-study methods were fully explained, including the grading of effort and showing how the fast and slow operators' time was compensated to give a normal time for the average operator. The enthusiastic assistance given later in lining up jobs for the time study proved that this method was time well spent.

The new standards were developed for the entire department to be applied in three major divisions of work as follows: (1) pressing, cleaning, and glazing, (2) loading and unloading kilns, and (3) contributing operations including mixing of raw materials, preparation of clay, glaze mixing, and sagger making.

Time studies were completed on all of the parts manufactured within (1) and (2) of the above labor divisions before any new standards were published. A complete turnover of the time standards was made at established dates, *i.e.*, at about two-month intervals. Contributing operations were set up last and were applied as soon as complete time studies were ended on each operation.

* Presented at the Annual Meeting, American Ceramic Society, Pittsburgh, Pa., February, 1933 (Management Session).

(1) Pressing, Cleaning, and Glazing These jobs were all set up and each operator was credited with his individual output. No particular problems were encountered except in the cleaning section where it was found that the removal of the burrs thrown up on the joint of a worn mold was considerably more of a task than on a new mold. Time standards for cleaning new and worn molds were set up. The standard for new molds covered about 75% of the production. The time for worn molds is allowed only after the foreman and the time-study man have agreed that the mold has worn to the stage warranting the extra allowance.

(2) Loading and Unloading Kilns This division of the work proved to be an interesting and successful application of time study. The time allowances were developed for two separate working groups, a loading group of seven men and an unloading group of five. All labor incidental to the preparation, packing, and loading of the saggers in the kiln was evaluated according to the size of the sagger. Definite specifications were set up on the planning cards showing the number of pieces per sagger of a given drawing number. The labor allotted to a given size sagger was divided by the pieces per sagger. Loading and unloading credits were then established from the production records showing the contents of each kiln.

(3) Contributing Operations Standards were set up for every job in the porcelain department with the exception of the tool room and the inspectors. The mixing of the raw materials for the preparation of the pulverized clay and the mixing of the glazing materials were measured and credited according to the number of batches made to established formulas. Sagger making and unloading of raw materials from freight cars were also measured by time standards.

Supervisory Bonus

After all of the direct operations had been time-studied and established, the important task arose of setting up the supervisory bonus standards. Definite allowances were set up for supervisory, clerical, trucking, and other service work and maintenance work. Normal losses were factored for scrappage which, if lowered, would increase the supervisory bonus. These standards were set up on what was considered a very conservative basis but, paradoxical as it may seem, even though the output per operation was greatly increased, scrap losses decreased appreciably.

The allowances for indirect work mentioned above were met and bettered, and resulted in a control of these expenses by the various key men, thereby relieving the management in its control of this expense.

The general results of the intensive job analysis, time study, and installation of time standards in the porcelain department have led to the conclusion that this class of work presents the same fundamental problems as other mechanical and assembly work. If these problems are carefully analyzed and sound judgment is used, time-study principles can be profitably employed and management will be given an improved instrument for effective planning and control.

General Electric Company
Pittsfield Works,
Pittsfield, Massachusetts

THE MANUFACTURE OF TERRA COTTA WALL BLOCK*

By P. William Lee

ABSTRACT

In this paper the principles of the manufacture of terra cotta wall block are discussed. These principles include the preparation of the body and its composition, the adjustment of the dies and the cutting table, the sizes and shapes of the block, troubles in drying, blistering, twisting, and their possible remedies.

I. Introduction

To meet the demand of modern architectural designs, terra cotta is now being made in larger pieces than formerly. With this trend from smaller to larger sizes for exterior work, architects now look forward to the use of a much larger size of block than enameled brick or wall tile for interior wall finishing. To meet this situation the terra cotta and other clay industries are now producing a new material which is called "the wall block." The qualities and sizes of this wall block are varied in a wide range. The machine-made blocks are of high quality.

* Presented at the Annual Meeting, American Ceramic Society, Pittsburgh, Pa., February, 1933 (Terra Cotta Division).

II. Clay Preparation

Certain manufacturers are making the block with clay alone without adding grog to the body. This type of block, of course, is made like conduit and hollow tile by feeding the ground clay directly into the pug mill and running it out through dies. The general practice with the terra cotta plants making terra cotta wall block is to prepare the body like the terra cotta body with 25 to 35% grog and with 14 to 17% water content. This makes a somewhat stiffer body than the hand-pressed terra cotta body. The first pugged clay can be introduced into the block machine with or without aging the clay. Since there is hardly any difference in the result between the aged and the unaged clay, it would be a labor-saving proposition if the prepugged body were introduced directly into the block machine.

III. Running the Block Machine

There are many types of machines made by different companies, but the principle of the machine is about the same in all cases. The block machine consists of a pugging trough, the auger, and the dies of various shapes attachable to the auger part. Some companies use the straight die while others use the curved bell-shaped die. The merits and demerits of the two kinds of shapes of dies are unknown and unfair for comparison. It may be logical, however, to think that the straight die is more adaptable to a plant where clay alone is used in the body so that the clay can make its own shape or path as it is forced out from the auger to the narrow portion of the die.

There are a few precautions to be taken in running the machine. (1) The die should be adjusted and balanced so that the clay column can run evenly through the die. The slightest unevenness of the pressure in the die will cause the block to curve in drying and firing or to crack while drying. (2) The die should be set absolutely level before the machine is run. (3) The cutting table should be set level and about one-eighth inch lower than the end of the die. (4) The speed of the machine should not be too fast or too slow. If the blocks are about sixteen inches long, eight blocks to one minute is about the best running speed. The speed can be controlled by careful feeding, by variable speed adjustment in the machine, and also by the water content of the body. The softer the clay the faster the column will run out. The feeding of the clay should be uniform when the speed of the machine is set. (5) The use of steam is quite essential to the die although an excessive amount is harmful. Steam acts as a lubricant and produces a smoother surface.

IV. Sizes and Shapes of the Blocks

Like terra cotta, these terra cotta wall blocks have no standard size or shape. Every plant seems to be manufacturing sizes best suited to meet their own demands. The depth of the blocks, however, is about the same. It is approximately 2, 4, and 6 inches. The regular ashlars are produced in sizes of 6 by 12 inches by the plants on the west coast, and 8 by $16^1/_4$ inches by the middle west and eastern plants. The base courses, the caps, the moldings, and the miters are varied in shape and size.

V. Troubles and Their Possible Remedies

Clay industries are subjected to more troubles than some of the other industries and in making simple wall blocks defects are encountered such as dry cracking, bending or curving, twisting, and blistering.

(1) Dry Cracking This trouble develops with the following conditions. (*a*) In an unevenly mixed body some portions of the block may be softer than others. A thorough aging or pugging of the clay will prevent this difficulty. (*b*) Uneven pressure in the die (the die not fully adjusted or balanced) will cause dry cracking. (*c*) A strong current of air passing through the blocks before they are placed in the drier will cause dry cracking. Blocks should be put into the drier or into closed rooms soon after they are loaded into the racks and should not be left in an open space where a strong air current is likely to strike them. (*d*) Fast drying will cause the drying crack. If the drier is not humidified drying should proceed gradually, especially during the first eighteen to twenty hours.

(2) Bending or Curving This trouble occurs from the following causes. (*a*) With too fast drying it has been found that the top courses or the upper portion of the racks showed more bending than the lower courses as a result of faster drying and uneven circulation of air in the drier. Covering the top of the racks with thick wet paper will minimize the bending.

A perfect condition of air circulation in the drier will also prevent this trouble. (*b*) Uneven pressure in the die will cause the blocks to curve. The curving produced with this uneven die pressure is different from the bending that is caused by too fast drying. The latter will cause the blocks to bend up and down, raising or lowering the center portion of the blocks, whereas the uneven pressure curving may give the same effect or may cause bending on the side of the blocks. It is important to adjust the dies to prevent this bending or curving in the blocks.

(3) Twisting This defect is believed to originate from the two twisted columns formed by the auger. This structure may not be entirely destroyed upon passing through the die and hence is similar in each block. This is a difficult problem and one that is hard to eliminate entirely. When the clay is stiffer the twisting is more pronounced than when the clay is softer. It has been the practice to put rings from three to six inches thick between the auger and the die. This increases the space between the auger and the die and retards the twisting of the column but does not entirely eliminate it. The increase of the space caused by inserting the ring raises the pressure in the auger and hence exerts high strain on the machine. The use of clay with 16 to 17% water content, which is the maximum amount of water permitting handling of the column, and a 3-inch ring inserted between the auger and the die or with some device to counteract the twisting will reduce this defect to a large degree.

(4) Blistering There have been many theories advanced on the cause of blistering. It was thought that the softer clay produced more blistering because the soft and larger clay lumps tend to pass through the auger carrying greater amounts of air which was thought to be the cause of air pockets. The defective pieces of the blocks thrown back to the pug mill were also thought to be a cause of blistering because the smooth faces and the oil in the clay make adherence to the fresh clay difficult. Using clay without aging has also been counted as one of the possible causes. Blistering is the result of the formation of air pockets after the clay column is gone through the die with a high pressure. All of these causes may be contributing factors toward the formation of air pockets.

Another important cause of blistering is the mixing of the compressed and hot clay which has been heated by the friction between the auger edges and the linings of the auger casing into the cooler clay. When the clay column coming out through the die is slower than the amount of clay entering into the auger from the feeding trough, it creates high pressure in the auger, increases the friction, and causes the clay to churn in the auger rather than to force it through the die. This action heats the clay higher than its desired temperature and produces a sheet of heated clay around the linings of the auger. This heated clay is pushed backward, broken into pieces, and then is mixed into the clay column and is pushed forward through the die. When the blocks are getting cold and are beginning to dry, the compressed air in the clay is forced out through the path of least resistance. The highly heated and compressed pieces of clay in the block do not adhere to the other clay causing air-filled laminations near the surface of the block which form blisters. To prevent this blistering, the following procedure is suggested: (*a*) The clay should be fed uniformly and not faster than the rate at which the column passes through the die. (*b*) The clay used should be as soft as possible. (*c*) The auger and the die should be kept cool, *i.e.*, the friction in the auger should not cause the clay to heat higher than 100°F. (*d*) The opening between the auger leaf and the linings should be kept as small as possible. More than $^3/_8$-inch clearance may cause blistering. (*e*) The slots of the linings should be kept in good condition by frequent renewals. This will facilitate the passage of the clay through the die and will tend to prevent its backward movement. (*f*) The de-airing of the clay may reduce blistering and may help to produce ware of better quality. With the de-airing process drying should be performed so as to reduce cracking and warping.

American Terra Cotta Company
Crystal Lake, Illinois

ACTIVITIES OF THE SOCIETY

Officers of the Industrial Divisions

L. E. Barringer, E. deF. Curtis	Art	George H. Brown, C. H. Peddrick, Jr.	Materials and Equipment	J. O. Everhart, W. C. Rueckel	Structural Clay Products
A. I. Andrews, W. N. Harrison	Enamel	R. A. Heindl, H. E. White	Refractories	R. F. Grady, Jr., H. E. Davis	Terra Cotta
H. H. Blau, S. R. Scholes	Glass			Louis Navias, R. F. Geller	White Wares

PROBLEMS SUGGESTED BY THE WHITE WARES DIVISION ADVISORY COMMITTEE TO THE BUREAU OF STANDARDS, 1931 AND 1933 COMMITTEES

Meeting to Be Held October 16, 1933, at U. S. Bureau of Standards, Washington, D. C.

(1) Raw Materials To amplify the present study of gases evolved by feldspar to include gases evolved at higher temperatures, using the induction furnace and studying both finely ground and rock samples.

(2) Raw Materials A study of the reaction of individual clays to water vapor in the autoclave and extending this study to the relative effects of these clays in typical earthenware bodies and in combination with different glazes (essentially a development of problem No. 7).

(3) Glazes The effect of temperature and time of heating on the size and distribution of bubbles in glazes (considered a part of the general problem given as No. 20).

(4) Methods To develop a rapid method of determining porosity by means of specific gravity.

(5) Bodies A study of artificial fluxes and the determination of their relative effects in bodies for the purpose of developing vitrified and water-absorbent white ware maturing at temperatures below 1000°C.

(6) Raw Materials The development of an equitable basis for the purchase of imported commercial clays containing relatively high amounts of moisture (suggested by the Eljer-California Company).

(7) Raw Materials A comprehensive study of English china clays to be extended to include American clays and to include a more thorough study of the various fractions of these clays.

(8) Glass A study of the glass phase in whiteware bodies (with the suggestion that this be amplified in time to include a study of the glass matrix *in situ* and also glasses melted *in vacuo versus* normally melted glasses).

(9) Bodies An X-ray study of commercial bodies (this problem might be considered as a later development of problem No. 27).

(10) Methods The physical testing of commercial bodies and glazes prepared and fired under commercial conditions.

(11) Glazes A study of the possibilities of using various naturally occurring calcium borates as raw material in the preparation of frit for earthenware glazes.

(12) Bodies The preparation of semivitreous bodies made entirely from American clays.

(13) Glazes Factors affecting the fluidity and density of raw glazes and the development of suitable methods of control of these properties to overcome "dipping" troubles.

(14) Glazes A study of the possibilities of including all of the lead in the frit and eliminating raw lead in glazes.

(15) Glazes The determination of the amount of lead oxide and boric oxide lost from whiteware glazes by vaporization (this problem would be considered as a part of problem No. 20).

(16) Glazes The development of commercial glazes of high resistance to solubility in hot dilute H_2SO_4 (encountered as a result of condensation of vapors in the cold end of tunnel kilns, the sulfur being derived from the fuel).

(17) Glazes The development of commercial glazes of high resistance to hot alkaline solutions as encountered in modern dish-washing machines.

(18) Methods The development of a simple and rapid test for the measurement of pressure-flow relations of plastic bodies.

(19) Bodies A study of the effect on the product of pugging bodies *in vacuo*.

(20) Glazes (PbO-SiO_2-K_2O) A fundamental investigation of the course of the reactions taking place during the fusion of those oxides used in the manufacture of glazes.

(21) Glazes The determination of the factors affecting the "spitting-out temperature" of glazes in decorating kilns.

(22) Bodies An investigation of gas temperature relations with particular reference to those gases present in ceramic kilns at temperatures used in the manufacture of white ware and including an investigation of the effects of these gases on whiteware bodies during the firing process.

(23) Raw Materials A study of salts occurring in raw clays and the effects of these salts on the working properties of clays during the preparation of bodies to be used in the manufacture of white ware. This would necessitate an investigation of colloidal phenomena including selective absorption, etc. (may be considered as one phase of the general problem given as No. 7).

(24) Bodies The effect of refiring on the properties of insulator bodies.

(25) Raw Materials The preparation of a résumé of investigations completed on feldspars together with a study of the relation of mineral constitution to rate of melting, the rate of solution of clays and flint in feldspar, the relative effects of blended *versus* unblended feldspars, and the possible formation of leucite in feldspar during the maturing of commercial bodies.

(26) Bodies A study of whiteware bodies under high-power magnification using ultra-violet and other light sources as reflected light.

(27) Raw Materials The determination of the ultimate constitution of clay and the changes which individual clays undergo when heated, including a study of the break-down products of other hydrated alumina silicates (this problem might be amplified to include problem No. 9).

(28) Method A study of the mechanics of dry-pressing including the determination of the relative effects of particle size and distribution in the body, the amount and nature of the fluid used, and the composition and condition of the atmosphere in which the pressing took place.

(29) Elimination of air from casting slip.
(30) General study of dunting.
(31) General study of warpage.
(32) The fitting of engobes and glazes to vitreous sanitary bodies.
(33) Relative resistance to abrasion of typical sanitary lead glazes maturing at cones 5 to 7 and of glazes which contain little or no lead and mature at cones 9 to 11.
(34) Relative resistance of different types of sanitary glazes to alkalis.
(35) The function of talc in bodies fired to cones 9, 11, and 13, with respect to the physical properties developed.
(36) Continuation of the basic study of the properties of typical glazes.
(37) Development of glazes of low thermal expansion.
(38) Viscosity of typical ceramic bodies at different temperatures using the Steger or similar apparatus.
(39) Study of the Steger test for the determination of the stresses existing between bodies and glazes.

REFRACTORIES DIVISION NOMINATIONS FOR 1934–1935

Trustee (three years)	R. B. Sosman
Chairman	H. E. White
Vice-Chairman	R. B. Sosman
Secretary	R. E. Birch
Nomination Committee	S. M. Phelps and R. A. Heindl

CINCINNATI—A CITY OF INDIVIDUALITY

Some cities, like certain rare types of people, escape the commonplace to acquire an individuality. A peculiar interest and charm growing out of their physical structure and perhaps more out of their less obvious traditions sets them apart as distinctively uncommon and noteworthy. They have managed to preserve the fundamental ideals that gave them character and flavor without losing step with the modern pace.

Members of the American Ceramic Society and their guests who attend the Annual Meeting in February may count the intriguing atmosphere of Cincinnati as no small part of their visit. Nothing could be more genuinely and fascinatingly modern than its new railroad terminal. Its shops and hotels are among the finest. It includes the most varied industries, a number of them international in scope. Its efficient, well-ordered government, its municipal university, its schools of music and art, its museums, its symphony orchestra, and its choral societies are famous the world over.

Cincinnati possesses a wealth of less tangible interest that may be all the lovelier because it is not so well known. To those accustomed to think of Ohio as a flat or gently rolling country there will be the surprise of finding the city dramatically and picturesquely perched on a number of high hills overlooking the broad Ohio river that still suggests the glamour of early pioneers and river steamboating. Now well-paved and graded thoroughfares connect the upper parts of the city with the lower, and spectacular viaducts of steel and concrete span the gaps between the hills. One of the earlier cable car inclines still remains, and one may reach Mount Adams to visit Rookwood and other fascinating spots of Old World charm by taking a trolley that is carried to the upper level on that incline. Or walking, one may avoid the winding grades and climb directly up the steep slopes about the city, over stepped sidewalks that go up and up like Jacob's ladder. From the heights there are breathless views.

Not more than five minutes from the Hotel Netherland Plaza is a little district known as Bethlehem, still inhabited by the sturdy German stock that first settled there. Cobbled streets green with grass wind along the side of a steep hill, houses press against the hill, and on the other side of the pavements are stone walls.

It should be realized too that Cincinnati is particularly rich in ceramic art. One need not mention Rookwood to ceramists. But there is much besides Rookwood. There is the Art Museum including, besides its famous collection of paintings, splendid exhibits of pottery, porcelain, and glass; the new railroad terminal with its fine use of terra cotta and its colorful mosaics by Winold Reiss; the Taft Museum with its gorgeous Chinese porcelains, its French enamels, and Italian majolica. Though Cincinnati is not usually thought of as a ceramic center there are interesting industries devoted to producing decalcomanias, decorated glass objects, stained glass windows, and enameled metal. The Applied Art School of the University of Cincinnati includes a department of ceramic design.

Other articles to appear will deal more fully with some of the interesting places mentioned.

"WIN WITH WISDOM"

A Message from the Membership Committee

The American Ceramic Society is the medium by which our industry interchanges valuable technical information pertinent to its well-being and future.

Corporate and personal members benefit not only from contributions in their own fields but in the contributions from allied fields, from the abstracts of all the current literature, and now from the newsy Bulletin. It is wise for corporations to avail themselves of all this valuable information and there is no other way to get it. It is only fair that they lend their whole-hearted support.

The ceramic technologist must be prepared with the last-minute information, and he can not be so well prepared for his job without being a member of the American Ceramic Society, thereby availing himself of its Journal, Abstracts, and Bulletin.

Therefore we may say—

To the Corporation Executive: Be wise. Be foresighted. Your Company needs the American Ceramic Society. The American Ceramic Society needs your support. Corporation membership is $25.00.

To the Technologist: Be wise. Be well informed. Be prepared for your job. You can not be so qualified without the help of the Journal, Abstracts, and Bulletin of the American Ceramic Society. Personal membership is $10.00.

NOTE: Naturally this appeal will be read to the greatest extent by members. It is hoped that they will volunteer their efforts to get corporation memberships and the personal memberships of their associates.

OUR THIRTY-SIXTH ANNUAL MEETING

February 11 to 16, Cincinnati, Ohio

The Cincinnati Committees, Samuel H. Eldridge, Chairman, have plans well along for a wonderful time in Cincinnati.

Harriet Spinks Carothers, R. B. Carothers, Fred A. Tobitt, Mac Booze, Harold Nash, H. F. Bopp, F. R. Henry, J. D. Whitmer, W. H. Pfeiffer, Fred Thompson, Hobart Kraner, and Erwin Sohn, with the collaboration of Warner Sayres of the Cincinnati Chamber of Commerce, intend that a pleasant and profitable week will be enjoyed by the ceramists. The technical program is well along to completion.

The skeleton program is as follows:

Sunday night: Concert and President's Reception

Monday forenoon: General Meeting
Monday noon: General Luncheon
Monday afternoon: General Meeting
Monday night: Dance, 9 P.M.

Tuesday forenoon: 8 Divisions
Tuesday noon: General Luncheon
Tuesday afternoon: 8 Divisions
Tuesday night: Fellow Lecture, 8 P.M., by Dr. A. L. Day

Wednesday forenoon: 8 Divisions
Wednesday noon: General Luncheon
Wednesday afternoon: 8 Divisions
Wednesday night: Supper

Thursday forenoon: General Meeting
Thursday afternoon: Excursions in Cincinnati

Friday: Excursions to Louisville, Middletown, and Dayton

ART DIVISION GENERAL SESSIONS PROGRAM

The Monday General Sessions will be devoted to ceramic art under the auspices of the Art Division for which the following tentative program has been prepared:

An Ancient Art Becomes a Modern Industry
By Robert A. Weaver, Ferro Enamel Corporation, Cleveland, Ohio

The Importance of Design in Modern Industry
By Joseph Sinel, Industrial Designer, New York, N. Y.

A Study of Representative Pottery Ware from Specimens in American Museums
By Edmund deF. Curtis, Conestoga Pottery, Wayne, Pa.

Art and Science in the Development of Rookwood Pottery
By Harold F. Bopp, Rookwood Pottery, Cincinnati, Ohio

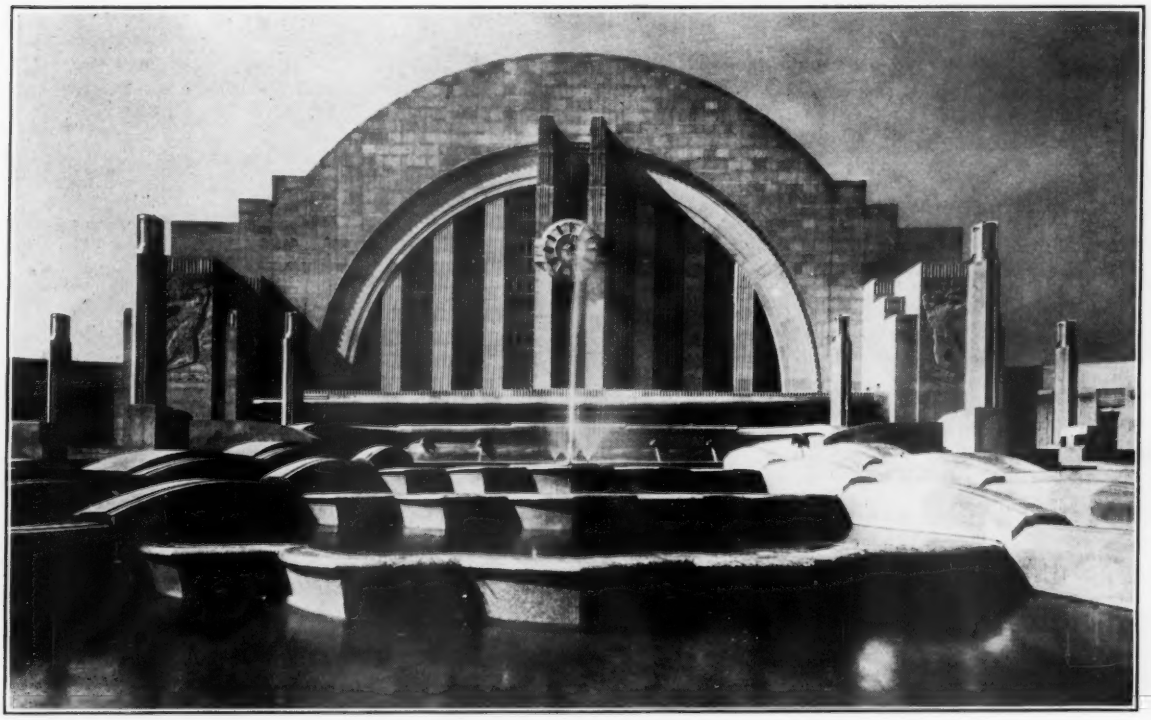
The Shapes and Decoration of Prehistoric Greek Pottery
By Dr. Hetty Goldman, Fogg Art Museum, Harvard University, Cambridge, Mass.

Indian Pottery of New Jersey
By Charles A. Philhower, Westfield, N. J.

Artistic Glass from 1900 to the Present Day
By Frederick Carder, Art Director, Corning Glass Works, Corning, N. Y.

NETHERLAND PLAZA HOTEL EMPLOYEES READY FOR CERAMISTS

Esperanto, the "universal" language, and Cherokee Indian are listed in addition to the twenty-four standard foreign languages as spoken by the Netherland Plaza employees. Several employees "speak" the sign language; all of them speak easy.



THE CINCINNATI UNION TERMINAL.

Cincinnati Is an Industrial City Plant Trips Are Planned for Annual Meeting Next February

ROOKWOOD POTTERY.

SAMUEL E. ELDRIDGE
Newport Rolling Mills Co.

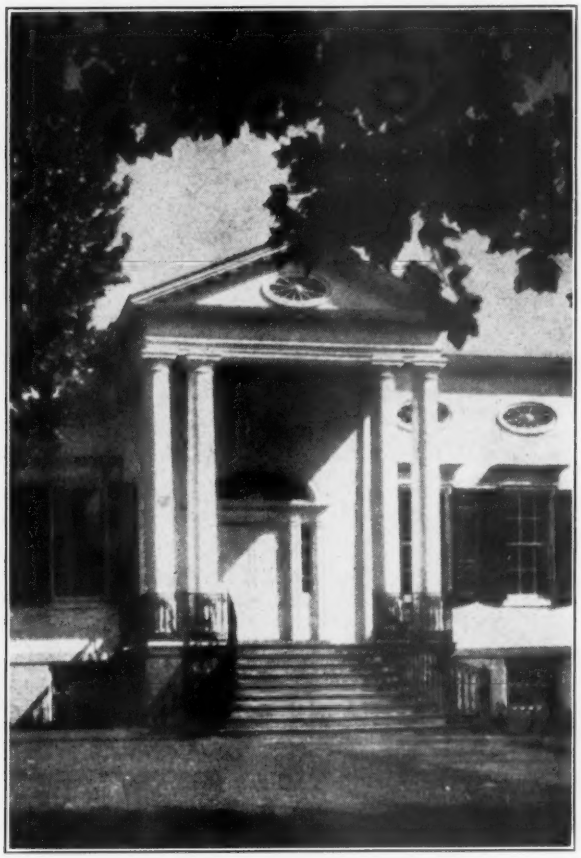
RICHARD B. CAROTHERS.
H. C. Spinks Clay Co.

MACDONALD C. BOOZE.
Charles Taylor Sons Co.

THE CAMBRIDGE-WHEATLEY COMPANY (OUTSIDE).

THE TAFT MUSEUM DIRECTORS INVITE THE AMERICAN CERAMIC SOCIETY TO VISIT THEM NEXT FEBRUARY

An invitation has been extended by the directors of the Taft Museum in Cincinnati, Ohio, to the members of The American Ceramic Society to visit the Museum next February at the time of the Thirty-Sixth Annual Meeting of the Society. The following description of the Museum will be of interest to those who avail themselves of this invitation.



FRONT DOORWAY OF THE TAFT HOUSE

In 1927 the Cincinnati Institute of Fine Arts was formed "to further the musical and artistic education and culture of the people of Cincinnati..." At that time Mr. and Mrs. Charles P. Taft gave one million dollars, their home and the land on which it stands, and their fine collection of paintings, porcelains, and other works of art conditional upon the contribution by others of two million five hundred thousand dollars for the purposes of the Institute. A campaign for the endowment fund was successfully completed on November 20, 1928, with subscriptions totaling over two million seven hundred thousand dollars. A beautifully bound and illuminated book dedicated to the Cincinnati Institute of Fine Arts and containing a history of its origin and foundation is to be found in the Music Room of the Museum. It contains the names of all donors to the Institute. This valuable record is the generous gift of Mr. Herbert Greer French. Mrs. Taft in her will bequeathed one million dollars to the Institute to be used for the reorganization of the house as a museum and for its maintenance. It is not alone this tangible expression of her generosity and that of her husband that we remember, but the thought and energy which they devoted to the accumulation of outstanding works of art. The Taft Museum stands today as an inspiring gift from them to the citizens of Cincinnati.

An attempt has been made to restore the house as nearly as possible to its original condition. Built in 1820 by Martin Baum, it has come down to us as an excellent example of the home of a gentleman of early Cincinnati. A careful study of the first decades of the nineteenth century was made before the plans for the restoration were executed. Reading in the newspapers of the period followed, and it was surprising what a large amount of information they contained, especially in the advertisements, concerning the furniture, wall treatments, and textiles used here at that time. The architecture, furniture, draperies, and rugs of the first quarter of the nineteenth century reveal a classical restraint which provides a dignified background for the Taft collection.

WALTER H. SIPLE, *Director*

EDWARD ORTON, JR., MEMORIAL LECTURE

To Be Presented by Dr. Arthur L. Day

The Edward Orton, Jr., Memorial Lecture for 1934 will be delivered in Cincinnati on Tuesday evening, February 13, by Dr. Arthur L. Day, Director of the Geophysical Laboratory, Washington, D. C.

Dr. Day has chosen as his subject "Natural and Artificial Ceramic Products."

The Orton Memorial Lectures are given annually under the sponsorship of the Fellows of the American Ceramic Society to honor the memory of Edward Orton, Jr., the founder of collegiate ceramic education in America and of the American Ceramic Society.

This is the second of the lectures, the first having been given at Pittsburgh on Feb. 14, 1933, by Dr. E. W. Washburn, Chief of the Chemistry Division of the Bureau of Standards, under the title, "The Phase Rule in Ceramics."

CINCINNATI UNION TERMINAL

By virtue of a central location between the Atlantic Seaboard and the Mississippi Valley and the remoter West and, further, in view of the fact that the city seemed to be the destined gateway to the South, Cincinnati early was entered by a railroad; presently by another, and so on to the proud day when she could boast of seven trunk lines.

The new Terminal brings the passenger service of all the railroads entering and serving the city together at a site conveniently situated less than one mile from the planned civic center of the near future.

The intersection of Central Parkway and Laurel Street is at the center of a circle which, with a radius of $1^1/_4$ miles, sweeps along the north bank of the Ohio River along Front Street for the whole distance between the Louisville and Nashville and the Cincinnati Southern, Ohio River bridges. Included within this circle, which also touches the west bank of Millcreek, are all five of the vanishing veteran railroad passenger stations and the beautiful Inwood, Lincoln, and Eden Parks as well as Redland Field.

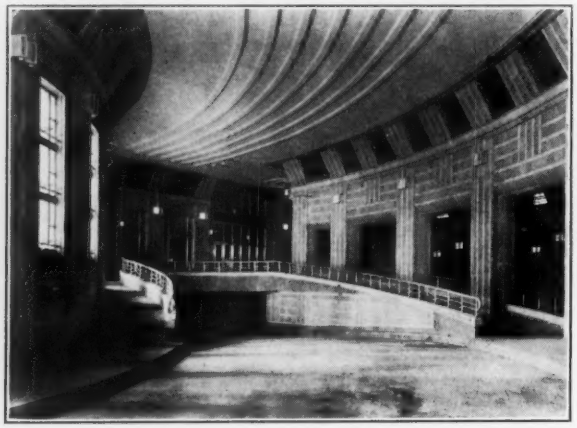
Within a circle of one mile radius from the same center

are found the new Court House, the Post Office on Government Square, the Dixie Terminal, City Hall, the Hotel Netherland Plaza, and the new Cincinnati Union Terminal.

From Music Hall westward the approach to the Terminal is along Laurel Street widened and improved by the city itself into what has, in these days, come to be known as a superhighway.

Freeman Avenue, an important north-south thoroughfare at the east end of Lincoln Park, is soon reached. From here the reconstructed Park engages the attention. The laudable decision of the city to reconstruct this park as a part of, and in harmony with, the vehicular approach to the new station has resulted in the creation of one of the finest approaches to a public or semipublic building to be found in America.

Corridor in Cincinnati Union Terminal.
Terra Cotta Corridors



Taxi ramp in Cincinnati Union Terminal.
Terra Cotta Ramps

NOTES AND NEWS

FALL MEETING OF THE CERAMIC ASSOCIATION OF NEW JERSEY

The Ceramic Association of New Jersey will hold the regular Fall Meeting on Friday, October 27, 1933, at the Stacy-Trent Hotel, Trenton, New Jersey.

OHIO CERAMIC INDUSTRIES ASSOCIATION ANNUAL MEETING

Columbus, Ohio, October 13 and 14

PROGRAM FOR MEETINGS

(1) Relative Abrasion Resistance of Ceramic and Competitive Flooring Materials by J. R. Shank
(2) Skidding Characteristics of Various Road Surfaces by K. W. Stinson
(3) The Metal Wear Research Program by G. A. Bole
(4) Drying Research in the Department of Ceramic Engineering, Ohio State University, by J. L. Carruthers
(5) The Present Status of Cellular Clay Products in the Insulation, Acoustic, and Construction Fields by G. A. Bole
(6) Flat Arch Floor Construction by G. E. Large
(7) Report on the Stage Pressing of Refractories by Benjamin Lassman
(8) The Mellon Institute Spall Test: an open forum led by M. C. Booze
(9) Further Researches in the Field of Insulating Refractories by W. C. Rueckel
(10) Needs for Research in the Sewer Pipe Industry by G. H. Duncombe
(11) Discussion of Clay Products in the Architecture of Tomorrow by Galen F. Oman

R. F. FERGUSON ASSOCIATED WITH THE TECHNICAL PRODUCTS COMPANY OF PITTSBURGH

Robert F. Ferguson has announced his association as research chemist with the Technical Products Company of Pittsburgh, manufacturers of "Insa-Lute" and other industrial adhesives.

SURVEY PROGRAM OF MONTANA STATE BUREAU OF MINES

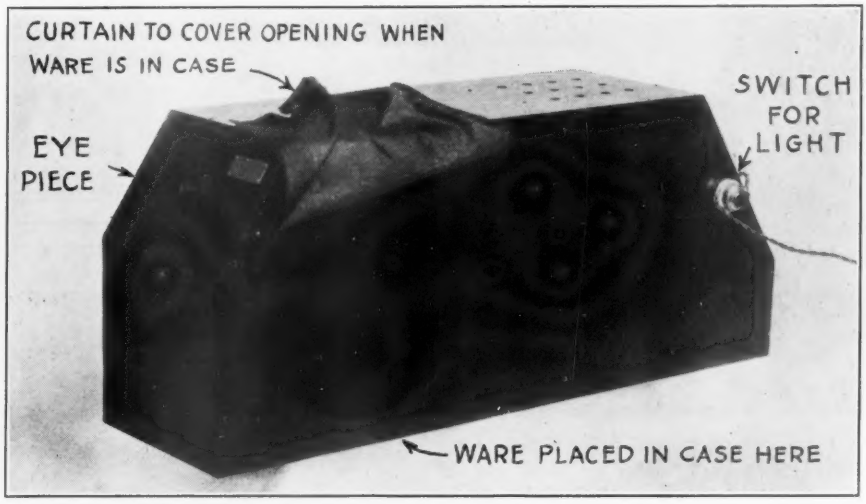
Adolph Kuechler on Clay Research

One of the largest programs of investigation ever sponsored by the Montana Bureau of Mines and Geology, extending to nearly all parts of the State, is under way despite reduced appropriations.

President Francis A. Thomson of the Montana School of Mines and director of the Bureau has announced that five major projects are listed on the program. The studies, which include an extensive research of Montana clay deposits, were begun on July 1, 1933, and will continue late into the fall.

Continuing the work initiated last year by Dr. Thomson on the study of Montana clay deposits, Adolph Kuechler, instructor of ceramics at the Mining College, is engaged in making a state-wide study of the most important clay fields. Mr. Kuechler, assisted by members of the Montana School of Mines staff, will spend about two months on his field researches, which will be followed by laboratory research during the winter.

SIMPLEX TYPE D POLARISCOPE



The aim is to furnish the manufacturer or laboratory with a high grade testing instrument which will show strains and cords in any kind of glass (opal, black or opaque glasses excepted).

With this polariscope the source of your trouble, whether annealing or glass conditions, can easily be determined and loss avoided.

Convince your customer that you are using every means to supply only perfect ware.

This polariscope uses no chemicals or liquids and yet the the slightest strain or cord shows up by a vivid contrast of colors.

Simply hold glass inside of case, look at it through the eye piece and if ware is perfect you will see only the shape of the article outlined against a pink background but a strain or cord will cause a vivid streak in the article of a different color.

SIMPLEX Equipment creates repeat orders and retains prestige.

SIMPLEX
ENGINEERING COMPANY
WASHINGTON TRUST BLDG. + WASHINGTON, PENNA., U. S. A.

Mr. Ceramist—

We have { *The Clay* / *The Facilities* / *The Experience*

H. C. SPINKS CLAY COMPANY
NEWPORT, KY.

THREE ELEPHANT
BORAX
REG. U.S. PAT. OFF. REG. U.S. PAT. OFF.
AND BORIC ACID
GUARANTEED OVER 99.5% PURE
AMERICAN POTASH & CHEMICAL CORPORATION
Woolworth Building, New York

"CERAMIC" COLORS

Increase Sales
BECAUSE *Buyer wants color* ★★★

Color consciousness has brought with it a demand for true and matched colors. "CERAMIC" Colors answer this with unvarying uniformity and consistent high quality. The use of "CERAMIC" Colors in the manufacture of their products assures glassware and pottery makers of buyer approval.

Our laboratories are available to help solve your color problem.

CERAMIC COLOR & CHEMICAL MFG. CO.
NEW BRIGHTON PENN'A.

Refractory Materials

Products of the Electric Furnace

SILICON CARBIDE
ARTIFICIAL MULLITE
SILICON CARBIDE FIRESAND
FUSED ALUMINUM OXIDE
FUSED MAGNESITE

Furnished in raw material form, ground to meet specifications.
Our Research Department with fully equipped laboratories is always at your service.
WRITE US ABOUT YOUR PROBLEMS

THE EXOLON COMPANY

Established 1914

Electric Furnace Plant { THOROLD, ONTARIO
Finishing Plant, General Offices { BLASDELL, N. Y.

PAPER MAKERS IMPORTING CO. INC. EASTON, PENNSYLVANIA, U.S.A. PMC INC

FINEST POTTERY CLAYS

BUYERS' GUIDE

A

Abrasives (Alundum-Crystolon)
Norton Co.

Aloxite (Refractory Products)
Carborundum Co.

Alumina (Hydrate and Calcined)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Aluminum Oxide (Fused)
The Exolon Co.
The Vitro Mfg. Co.

Alundum (Refractory Products)
Norton Co.

Ammonium Bifluoride
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Ammonium Carbonate
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Antimony Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

B

Ball Mills
McDanel Refractory Porcelain Co.

Ball Mills (Laboratory Type)
Ceramic Color & Chemical Mfg. Co.

Barium Carbonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Batts
Carborundum Co. (*"Carbofrax Aloxite"*)
Norton Co. (*Alundum Crystolon*)

Bitstone
Potters Supply Co.

Blocks (Refractory)
Carborundum Co.
Norton Co.

Borax
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Pacific Coast Borax Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Borax Glass
Pacific Coast Borax Co.

Boric Acid (Anhydrous)
Pacific Coast Borax Co.
The Vitro Mfg. Co.

Boric Acid (Crystal, Granular, or Powder)
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Pacific Coast Borax Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Bricks (Refractory)
Carborundum Co. (*"Carbofrax Aloxite"*)
Norton Co.

C

Carbofrax (Refractory Products)
Carborundum Co.

Carbolon (Refractory Products)
The Exolon Co.

Carbonates (Barium, Lead)
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Caustic Soda
Ceramic Color & Chemical Mfg. Co.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Cements
Carborundum Co.

Ceramic Chemicals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Chromium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Clay (Ball)
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.
The Roessler & Hasslacher Chemical Co.
Spinks Clay Co., H. C.
The Vitro Mfg. Co.

Clay (China)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Edgar Brothers Co.
Hammill & Gillespie, Inc.
Paper Makers Importing Co.
The Vitro Mfg. Co.

Clay (Electrical, Porcelain)
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.
The Vitro Mfg. Co.

Clay (Enamel)
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Metal & Thermit Corp.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Clay (Fire)
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.

Clay (German Vallendar)
Ferro Enamel Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Clay Miners
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clay (Potters)
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clay (Sagger)
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (Wad)
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (Wall Tile)
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clocks (Gauge Board)
Ferro Enamel Corp.

Cobalt Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Colors
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Cornwall Stone
Hammill & Gillespie, Inc.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Cornwall Stone (Imported)
The Roessler & Hasslacher Chemical Co.

Crucibles (Filter, Melting, Ignition)
Norton Co.
Potters Supply Co.

Crystolon (Refractory Products)
Norton Co.

D

Decorating Supplies
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Drying Machinery
Ferro Enamel Corp.

E

Electrical Porcelain
Paper Makers Importing Co.

Enameling Equipment (Complete)
Chicago Vitreous Enamel Products Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

Enameling Furnaces
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Norton Co.
Porcelain Enamel & Mfg. Co.

Enameling Iron (Sheet)
American Rolling Mill Co.

Enameling Muffles
Carborundum Co. (*Carbofrax*)
Norton Co. (*Alundum*)

Enameling (Practical Service)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Enamels
Ceramic Color & Chemical Mfg. Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Enamels (Porcelain)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Metal & Thermit Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Equipment (Porcelain Enameling)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

Exolon (Refractory Products)
The Exolon Co.

BUYERS' GUIDE (continued)

F

Feldspar
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Fire Brick
Carborundum Co.
Norton Co.

Flint
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Flint Pebbles
Ferro Enamel Corp.

Floors (Non-Slip)
Norton Co.

French Flint
Paper Makers Importing Co.

Frit
Ceramic Color & Chemical Mfg. Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Furnace
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

G

Glaze and Body Spar
Ceramic Color & Chemical Mfg. Co.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Glazes and Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Glaze Spar
Ceramic Color & Chemical Mfg. Co.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Gold
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Grinding Wheels
Norton Co. (*Alundum Crystolon*)

H

Hearths
Carborundum Co.
(*Carbofrax* heat treating)
Norton Co. (*Crystolon*)

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Norton Co.

I

Iron (Enameling)
American Rolling Mill Co.

K

Kaolin
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Kilns (China, Decorating)
Drakenfeld & Co., B. F.

Kryolith
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

L

Leeds (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.

Linings (Furnace Refractory, Block Refractory Plate, Brick and Tile)
Carborundum Co.
Norton Co.

M

Magnesia (Sintered, Calcined)
The Exolon Co.
Norton Co.

Magnesite
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Manganese
Ceramic Color & Chemical Mfg. Co.
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The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Metals (Porcelain Enameling)
American Rolling Mill Co.

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The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Muffles (Furnace)
Ferro Enamel Corp.
Carborundum Co. (*Carbofrax*)
Norton Co.

Mullite (Artificial)
The Exolon Co.

Muriatic Acid
Pennsylvania Salt Mfg. Co.

N

Nitrates (Cobalt, Sodium)
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

O

Opacifiers
Ceramic Color & Chemical Mfg. Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
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Oxides
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Titanium Alloy Mfg. Co.
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P

Pins
Potters Supply Co.

Porcelain Enameling Service (Practical)
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Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
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Porcelain Enamels
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The Vitro Mfg. Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
McDanel Refractory Porcelain Co.

R

Refractories
Carborundum Co.
The Exolon Co.
Norton Co.

Refractory Materials
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The Exolon Co.
Norton Co.

Rutile
Ceramic Color & Chemical Mfg. Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

S

Saggers
Carborundum Co.
Norton Co.
Potters Supply Co.

Selenite of Sodium
Drakenfeld & Co., B. F.
The Vitro Mfg. Co.

Selenium
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Sheets (Enameling Iron)
American Rolling Mill Co.

Silica (Fused)
The Exolon Co.

Silicate of Soda
Ceramic Color & Chemical Mfg. Co.
Philadelphia Quartz Co.
The Vitro Mfg. Co.

Silicon Carbide
The Exolon Co.
Norton Co.

Silicon Carbide Firesand
The Exolon Co.

Sillimanite (Synthetic)
The Exolon Co.

Slabs (Furnace)
Carborundum Co.
Norton Co.

Smelters
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

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Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Sodium Antimonate
Ceramic Color & Chemical Mfg. Co.
Metal & Thermit Corp.
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The Vitro Mfg. Co.

Sodium Fluoride
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The Roessler & Hasslacher Chemical Co.
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Stilts
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The Roessler & Hasslacher Chemical Co.

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Ferro Enamel Corp.

Tile (Refractory)
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Norton Co.

Tile (Wall)
Ferro Enamel Corp.
Paper Makers Importing Co.

Tin Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Titanium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Titanium Oxide
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Tubes (Insulating)
McDanel Refractory Porcelain Co.
Norton Co.

Tubes (Pyrometer)
McDanel Refractory Porcelain Co.
Norton Co.

W

Wet Enamel
Ceramic Color & Chemical Mfg Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Whiting
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.

Z

Zirconia
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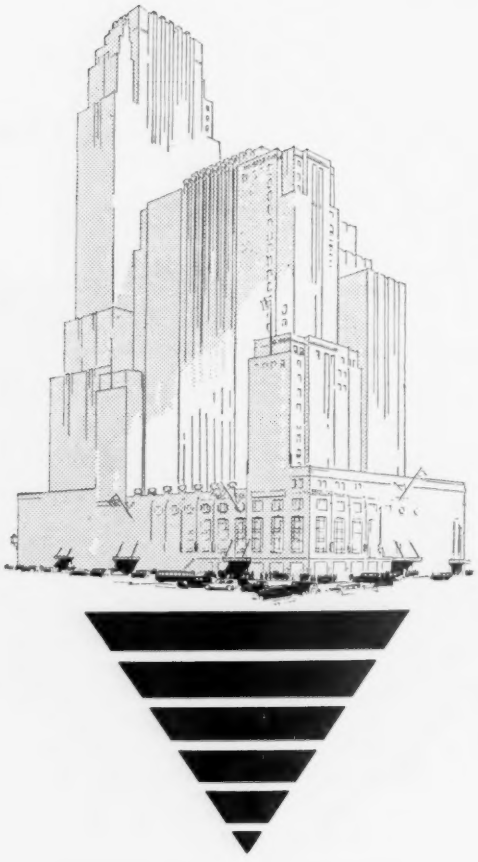

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